

Marsh (O.C.)

Capt E. Butler  
With the kind regards of  
O. C. Marsh

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DISCOVERY  
OF  
ADDITIONAL REMAINS OF PTEROSAURIA,  
WITH DESCRIPTIONS OF TWO NEW SPECIES.

DISCOVERY OF THE  
DERMAL SCUTES OF MOSASAUROID REPTILES.

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DISCOVERY  
OF  
ADDITIONAL REMAINS OF PTEROSAURIA,  
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BY PROFESSOR O. C. MARSH.



THE first remains of Pterodactyls detected in this country were found in the upper Cretaceous shale of Western Kansas, by the writer, during the explorations of the Yale College party in the autumn of 1870. The specimens then obtained, although very fragmentary, were deemed sufficiently characteristic for determination, and the gigantic species they were believed to represent was briefly described under the name *Pterodactylus Oweni*.\* The great interest attached to these remains led to a careful reëxamination of the same region by the Yale party of the following year, and with most gratifying results. An excavation at the point where the first specimens were found yielded further portions of the same skeleton, and, at various localities in the same strata, other specimens were secured, which not only throw much light on the species first discovered, but also prove the existence of two other Pterosaurians, likewise of great size, showing that these peculiar reptiles, so long deemed wanting in America, were apparently well represented here during the later Cretaceous.

\* This Journal, vol. i, p. 472, June, 1871. As this name had already been applied provisionally by Seeley to a Pterodactyl from the Greensand of England, the present species may be called *Pterodactylus occidentalis*.



*Pterodactylus occidentalis* Marsh.

The additional remains of this species discovered by our party during the past summer, consist of portions of five individuals, which differed somewhat in size, but all tend to confirm the conclusions based on the fragments first examined. From the locality which furnished one of the original specimens, we recovered the proximal end of the right, wing-finger metacarpal, which evidently belonged with the distal extremity described, and proves the entire bone to have been at least fifteen inches in length, or much more elongated than any hitherto known. With this specimen were found portions of the second and third phalanges of the same wing-finger, all indicating the great size and power of the wings. Another specimen, found by the writer at a higher level, in the yellow chalk, pertained to a larger individual, and is of much interest. It consists of the distal extremity of the left-wing metacarpal, articulated to the adjoining proximal end of the first phalanx. Both bones are in excellent preservation, and show this characteristic joint most perfectly.

The most important remains of this species yet discovered, however, consist of nearly all the bones of a right wing, from the humerus to the last phalanx inclusive, which were found by the writer in place in the gray Cretaceous shale, during our investigations near the Smoky River. Although more or less fractured, the bones are in general well preserved, and show clearly the peculiar structure of the Pterosaurian wing, as well as the especial characters that mark the present species.

The humerus, which is nearly perfect, is remarkably short and robust, and in its main features surprisingly bird-like. The articular head is large and crescentic, convex on its anconal face, and concave on the opposite side. Its proximal outline is concave transversely, thus differing widely in this respect from the avian type. The ulnar crest is very prominent, and its proximal extension is continued to the line joining the radial and ulnar angles of the articular head. The radial crest is prominent, but scarcely exceeds the ulnar ridge in size, and is hence proportionally much smaller than in most of the Pterodactyls described. Its point of greatest extension is nearly opposite the distal subsidence of the ulnar crest. There is no

pneumatic foramen on the anconal side of the proximal extremity. The shaft of the humerus is smooth, sub-cylindrical in transverse outline, and apparently less sigmoid longitudinally than in the species already known. The osseous walls are thin, and very compact. The distal extremity is much flattened, and has the articular condyles very similar to those in the humerus of birds. The radial condyle is the larger, and more prominent. It is oval in outline, and extends obliquely rather more than half way to the ulnar side. Near its termination on the palmar surface, and on the ulnar side of the median line, is a large, oval, pneumatic foramen. There is here no indication of an impression for the attachment of the anterior brachial muscle, as in the humerus of birds. The ulnar condyle is transversely oval in form, and is separated from the radial condyle by an oblique groove. The principal dimensions of the humerus are given in the table below.

The fore-arm in the present specimen was composed of two separate bones, which differ much in size. The larger bone was apparently the ulna, and its proximal end covered with its articular faces the greater portion of the condyles of the humerus. The smaller or radial element was closely attached to the larger bone on its front or palmar side. Both of these bones had unfortunately been crushed, and the shafts badly fractured, so that their exact length cannot be accurately ascertained. They were, however, at least thirteen and a half inches long, and probably much more. With exception of the much greater difference of the two bones in size, they appear to resemble most nearly the anti-brachial bones of *Pterodactylus Suevicus*, as figured by Quenstedt.\* With the above specimens were exhumed three bones belonging to the wrist; a large proximal carpal, a distal one of nearly equal size, and a third, much smaller, which is probably a lateral carpal. The two larger bones correspond essentially in their main features with those of *Pt. Sedgwickii*, figured by Owen,† although they indicate a superior size for the present species.

The metacarpal of the wing-finger in this series of specimens is represented only by its distal extremity, so that its dimensions

\* Ueber *Pterodactylus Suevicus*, 4to, Tübingen, 1855.

† Fossil Reptilia from Cretaceous, Third Supplement, pl. iv.



must be determined mainly from a comparison with the other specimens pertaining to this species. The part preserved resembles strongly the distal end of the tibia of a bird, but differs essentially in the obliquity of its condyles—which have a sweep of about two thirds of a circle—and in the presence of a large pneumatic foramen on the palmar side, in the depression between the condyles. On the opposite side there is no indication of a similar opening. There was also, apparently, no median rising in the groove of the distal end, either in the present specimen, or in others of the same species. The outer trochlear surface is most developed, and has its exterior margin angular. In its proximal extension on the palmar side, it bends outward, and terminates in an obtuse lateral tubercle, which forms, on its articular surface, nearly a right angle with the side of the adjoining shaft. The inner trochlear surface has a rounded interior margin, and, on the anconal side, ends abruptly in a prominent ridge, which limits the lateral motion of the joint.

There were four phalanges in the wing-finger, and the greater portion of all of them is preserved. The first phalanx is almost entire, and measures about seventeen inches in length. Its proximal end presents the peculiar articulation for union with the metacarpal, which is well shown in the figures given by Quenstedt, von Meyer and Seeley. The outer articular face, or that on the ulnar side, is broad, nearly flat transversely, and forms almost a right angle with the adjoining side of the shaft. The inner face is shorter, deeply concave transversely, with a thin exterior edge. The two articular faces converge, and unite on a sub-triangular olecranon process, which projects proximally from the anconal side of the shaft, thus moving between the condyles of the adjoining metacarpal, and preventing the flexure of the point beyond the full extension of the wing. On the opposite side, between the articular faces, there is a deep groove, which is continued some distance distally. It apparently contains a large pneumatic foramen. The distal end of this bone presents an elliptical, convex, articular face, which does not entirely cover the distal surface. The second phalanx has its proximal extremity adapted to this articular face by a shallow elliptical cup, which does not extend over the most proximal portion of the extremity. The distal end resembles

in everything but size the corresponding part of the first phalanx. The next or third phalanx is quite similar to that which precedes it, except that it is more attenuated. The slender terminal phalanx appears to have been more nearly circular at its proximal end, although apparently compressed toward its other extremity. The articular surfaces of all the bones preserved are smooth and well defined, like those of mammals and birds. All the bones of the wing, moreover, even the carpals, appear to have been pneumatic.

The teeth found with remains of this species, and supposed to belong with them, are very similar to the teeth of *Pterodactyls* from the Cretaceous of England. They are smooth, compressed, elliptical in transverse outline, pointed at the apex, and somewhat curved.

The following are the principal dimensions of the specimens mentioned in the previous description. Some of the measurements are only approximately correct, owing to the distortion by pressure of several of the specimens:

*Measurements.*

Length of humerus on radial side,.....	163· mm.
Length on ulnar side,.....	174·
Greatest diameter of articular head,.....	38·
Least diameter of articular head,.....	12·
Greatest diameter or width of proximal end,.....	63·
Greatest diameter of distal end,.....	64·
Vertical diameter of shaft, where least,.....	29·
Length (minimum) of ulna, or larger bone of fore-arm,...	336·
Greatest diameter at proximal end,.....	48·
Greatest diameter of articular surface,.....	46·
Greatest diameter of distal end,.....	42·
Greatest diameter of radius, at proximal end,.....	33·
Greatest diameter at distal end,.....	28·
Transverse diameter of proximal carpal,.....	51·
Antero-posterior diameter of proximal carpal,.....	28·
Greatest diameter of articular face of distal carpal,.....	42·
Length of lateral carpal,.....	24·
Length (minimum) of metacarpal of wing-finger,.....	412·
Length of first phalanx of wing-finger,.....	428·
Transverse diameter of proximal end,.....	53·
Chord of greater articular surface,.....	30·



Length of olecranoid process,.....	20 mm.
Greatest diameter of distal end,.....	29
Greatest diameter of distal articular surface,.....	35
Least diameter,.....	8
Greatest diameter of second phalanx, at proximal end,---	35
Greatest diameter of proximal articulation,.....	28
Greatest diameter of distal articulation,.....	20
Least diameter,.....	6
Greatest diameter of proximal articulation of third phalanx, 18	
Least diameter,.....	7
Greatest diameter of proximal articulation of fourth phalanx, 10	
Length of crown of tooth,.....	25
Antero-posterior diameter at base,.....	9
Transverse diameter at base,.....	5.5

The above measurements of the wing-bones would indicate for the entire wing a length of at least eight and a half feet, and, for the full expanse of both wings, a distance of eighteen to twenty feet. The present species, therefore, contains some of the largest "flying dragons" yet discovered. Its main distinctive features are readily seen in the very short and stout bird-like humerus, with its moderate radial crest, and large distal pneumatic foramen; in the separate radius and ulna, differing greatly in size; and in the extremely elongated wing-metacarpal. The latter character renders it almost certain that the species belonged to the short-tailed or true Pterodactyls, as in the other groups this bone has been found to be invariably less than one-half the length of the fore-arm. The large laniary teeth clearly indicate the carnivorous and predacious habits of the species, and its food was doubtless fishes, which it captured probably by plunging into the water, like the Pelicans and other similar birds.

All the known remains of this species were found in the upper Cretaceous strata, near the Smoky River in Western Kansas.

*Pterodactylus ingens*, sp. nov.

The existence of a second and much larger species of Pterodactyl, in the same strata with the remains just described, is clearly indicated by a number of specimens, pertaining to four individuals, which were discovered last summer during the ex-



plorations of the Yale party along the Smoky River and its tributaries. One series of these specimens consists of the greater portion of an ulna, part of a radius, the distal end of a wing-metacarpal, and portions of the corresponding phalanges, evidently belonging to the right wing of the same animal. The other specimens secured are equally characteristic, and serve to supplement this series.

A comparison of these various remains, especially the bones of the fore-arm, with the corresponding parts of the preceding species, shows several important differences, aside from that of size. In the former species, the ulna, or larger anti-brachial bone, has, on its proximal end, two large articular faces for union with the condyles of the humerus, and between them a low elevation, which extends only to a line joining the proximal margins of these surfaces. In the large species, this elevation is represented by a very prominent, flattened protuberance, which projects far beyond the rest of the proximal extremity. The smaller articular face in this specimen, moreover, is much less inclined from the axis of the shaft. The distal ends of the same bones show equally marked differences. In *Pt. occidentalis*, the articular face on the outer side extends transversely only to the margin of the central tubercle. In the species under consideration, this face does not terminate until it reaches a point opposite the middle of the corresponding projection, which is much more compressed than in the smaller specimen. The radii, also, of the two species exhibit essential differences, especially in their proximal extremities.

The metacarpal bone of the wing-finger is very similar at its distal end to that of the species above described. It shows, however, unmistakable indications of a median ridge on its anconal side; and since this is also the case with all the other specimens preserved, there can be little doubt that this feature was a specific character. The remaining portions of the phalanges, so far as the present material allows of comparison, show no essential differences in the two species.

With one series of the above specimens, a small bone was found, which is probably the distal end of a metatarsal. In its general features it agrees most nearly with the bone figured by Seeley as a metacarpal or metatarsal.\* The fact that this speci-

\* Ornithosauria, plate vi., figures 8 and 9.

men is nearly solid bone would be an argument for considering it the latter, as all the wing-bones examined during the present investigation are clearly pneumatic.

The dental characters of this species are at present only known from a single crown of a tooth, found with one series of the specimens, and from two larger and very perfect teeth found by themselves, which agree so closely with the former that they deserve notice in this connection. These specimens are less curved and less compressed than the teeth referred to *Pt. occidentalis*, but in other respects they are nearly identical.

#### Measurements.

Greatest diameter of ulna, at proximal end,.....	67·	mm.
Greatest diameter, at distal end, .....	68·	
Greatest diameter of radius, at proximal end,.....	44·	
Transverse diameter of wing-metacarpal, at distal end,...	38·75	
Transverse diameter of shaft, at junction with condyles, .	32·	
Antero-posterior extent of outer condyle, on palmar side, .	34·	
Antero-posterior extent of inner condyle, on palmar side, .	35·	
Transverse diameter of proximal end of first wing-phalanx, .	41·	
Length of olecranon process beyond outer articular face, .	32·5	
Transverse diameter of supposed metatarsal, at distal end, .	14·	
Length of crown of small tooth found with above remains, .	18·6	
Antero-posterior diameter, at base of crown, .....	7·25	
Transverse diameter, .....	5·	
Length of large isolated tooth, .....	48·	
Antero-posterior diameter at base of crown, .....	14·	
Transverse diameter, .....	11·3	

The present species was evidently one of the most gigantic of Pterosaurs. It was at least double the bulk of *Pterodactylus occidentalis*, and probably measured between the tips of the fully expanded wings nearly twenty-two feet!

The various remains on which the species is based were discovered, in July last, by Lieut. J. H. Whitten, U. S. A., Mr. O. Harger, of Yale College, and the writer. The localities were in the blue shale and yellow chalk of the Upper Cretaceous, near the Smoky River, in Western Kansas.

*Pterodactylus velox*, sp. nov.

This species, which was apparently about two thirds the size of *Pterodactylus occidentalis*, is at present represented, so far as known, by the distal end of a right metacarpal of the wing-finger, and by the proximal extremity of the adjoining first phalanx. These bones, however, are among the most characteristic parts of the Pterosaurian skeleton, and in the present instance the specimens appear to show several points of distinction from the species already described.

In the metacarpal bone, the articular distal extremity is smaller in proportion to the size of the shaft which supports it, than in either of the species above described. In other respects it appears to present no essential difference except that of size. The first phalanx, however, shows in its proximal end several differences which are clearly of specific importance. The outer articular surface in the present specimen is proportionally much narrower, and has its posterior margin more extended proximally. There is, moreover, no indication, on the inner side of the bone, of the large obtuse tubercle which is a prominent feature in all the corresponding specimens of the other two species. The epiphysis which bears the olecranoid process has disappeared from the present specimen, leaving an elongated oval depression, with a well defined margin. Both of the above bones are somewhat distorted by pressure.

*Measurements.*

Transverse diameter of wing-metacarpal, at distal end, . . .	26 <sup>·</sup> mm.
Proximal extent of outer condyle, on palmar side, . . . . .	22 <sup>·</sup> 6
Proximal extent of inner condyle, . . . . .	20 <sup>·</sup>
Transverse diameter of shaft at junction with condyles, . .	21 <sup>·</sup>
Antero-posterior diameter of proximal end of first phalanx, 38 <sup>·</sup>	
Greatest transverse diameter, . . . . .	12 <sup>·</sup>

The specimens of this species at present known do not afford perfectly reliable data for estimating the size of the animal, but the wings, when fully expanded, were probably from twelve to fifteen feet in extent. The fossils here described were found by the writer, in July last, in the gray cretaceous shale, on the south side of the Smoky River, in Kansas.

Yale College, New Haven, Conn., Feb. 26th, 1872.



*Discovery of the Dermal Scutes of Mosasauroid Reptiles; by*  
Professor O. C. MARSH.

THE great abundance of *Pythonomorpha* in the Cretaceous deposits of this country is rapidly affording material for a full understanding of the structure of these peculiar reptiles, about which, until recently, so little has been known. The explorations of the Yale College party in Western Kansas, in 1870, first proved the existence of posterior limbs, in three of the genera,\* and the same party, during their investigations of the past year in that region, have added several other important facts, one of which is, that these reptiles were protected by osseous, dermal plates, a point of much interest in determining their true affinities. An examination of a large number of specimens has shown that this covering existed in *Edestosaurus*, *Liodon*, *Holcodus* and *Clidastes*, and hence there can be little doubt that it was common to the entire group.

The plates were first observed in a specimen of *Edestosaurus*, on which several were adhering to portions of the skull and lower jaws. A few of these were attached together, apparently in their original position with reference to each other, thus indicating their natural arrangement. There were evidently at least two or three kinds of scutes, and all of those preserved are essentially quadrilateral in form, the posterior margin being the shortest. The lower surface is smooth. The upper side has the margin more or less beveled, to admit an imbricate arrangement when in place, but no true ornamentation. The edges are, in general, quite thin, but one shows that it was united by suture. There are also indications of an imperfect articulation, somewhat like that seen in the plates of some species of *Palæoniscus*.

The exact arrangement of the scutes when in place is difficult to ascertain from the limited number of specimens observed, but a complex pattern was evidently produced by alternate rows

\* This Journal, vol. i. p. 447, June, 1871.

of scutes of different shape and size. In some places, the edges overlapped in such a way as to bring three thicknesses together. The position in which the plates were found would indicate that they were mainly from the lower part of the neck.

*Measurements.*

Length of large scute of <i>Edestosaurus</i> ,.....	28·mm.
Width at anterior margin,.....	27·
Width at posterior margin,.....	9·
Greatest thickness,.....	3·
Length of small scute of <i>Edestosaurus</i> ,.....	18·
Width at anterior margin,.....	18·
Width at posterior margin,.....	12·
Greatest thickness?.....	1·5

In the genus *Liodon*, the scutes are also imbricate, and somewhat similar to those above described; but all observed appear to be proportionally smaller. Those found with one specimen are quadrilateral in form, with the posterior margin shortest. They are smooth below, but the upper surface is rugose. The exposed portion is linguiform, with its longer axis corresponding to that of the scute. One perfect scute was 26 mm. in length, 20 in average width, and 4·25 in thickness. The scutes in *Holcodus*, so far as observed, resemble those of *Liodon*. In *Clidastes*, the only scutes detected were some fragments adhering to the caudal vertebræ of *C. Wymani* Marsh. They are very thin, and quite smooth.

The various specimens examined in this investigation render it probable that the cranium of these reptiles was not covered with plates, but the body only, as in some of the Crocodilia. The scutes are apparently different in each species, and hence are important as a means of identification.

Yale College, New Haven, March 5th, 1872.









